AMENDMENTS TO THE CLAIMS

This listing of claims replaces all prior versions, and listings, of claims in the application.

1. (Withdrawn) A method for controlling materials quality in a rolling, forging, or leveling process, the method comprising:

conducting, at least once, each of heating a metallic material, rolling, forging, or leveling the metallic material, and cooling the metallic material; and

prior to manufacture of a metallic product of a desired size and shape, measuring qualitative data of the metallic material at a measuring position, using a materials quality sensor installed in a manufacturing line, and, in accordance with the qualitative data measured, making modifications to at least one of heating, processing, or cooling conditions upstream of the materials quality sensor so that the qualitative data of the metallic material at the measuring position agrees with target data.

2. (Withdrawn) A method for controlling materials quality in a rolling, forging, or leveling process, the method comprising:

conducting, at least once, each of heating a metallic material, rolling, forging, or leveling the metallic material, and cooling the metallic material; and

prior to manufacture of a metallic product of a desired size and shape, measuring qualitative data of the metallic material at a measuring position, using a materials quality sensor installed in a manufacturing line, comparing the qualitative data measured with metallic material quality data estimates at the measuring position that have been calculated from actual heating conditions, processing conditions, and cooling conditions of the metallic material, using a materials quality model, modifying the materials quality model in accordance with results of the comparison, and determining subsequent heating conditions, processing conditions, and cooling conditions of the metallic material using the materials quality model as modified.

3. (Withdrawn) A method for controlling materials quality in a rolling, forging, or leveling process, the method comprising:

conducting, at least once, each of heating a metallic material, rolling, forging, or leveling the metallic material, and cooling the metallic material; and

prior to manufacture of a metallic product of a desired size and shape, measuring qualitative data of the metallic material, using a materials quality sensor installed in a manufacturing line, and, in accordance with the qualitative data measured, calculating at least one of heating, processing, or cooling conditions of the metallic material, downstream with respect to the materials quality sensor, using a materials quality model so that quality of the metallic material at a materials quality control point located at any position downstream with respect to the materials quality sensor will agree with target data.

4. (Withdrawn) A method for controlling materials quality in a rolling, forging, or leveling process, the method comprising:

conducting, at least once, each of the heating a metallic material, rolling, forging, or leveling the metallic material, and cooling the metallic material; and

prior to manufacture of a metallic product of a desired size and shape, measuring qualitative data of the metallic material, using a materials quality sensor installed in a manufacturing line, and, in accordance with the qualitative data measured, modifying at least one of heating, processing, or cooling conditions of the metallic material, downstream with respect to the materials quality sensor, using a materials quality model so that the quality of the metallic material at a materials quality control point located at any position downstream with respect to the materials quality sensor will agree with target data.

5. (Withdrawn) The rolling process materials quality control method according to claim 1, wherein the manufacturing line comprises

a water-cooling site immediately after of a processing site which uses a rolling mill, and

a materials quality sensor at both or either of two locations, one location being between the processing site and the cooling site, and the other location being an outlet of the cooling site.

6. (Withdrawn) The materials quality control method according to claim 1, wherein the materials quality sensor comprises ultrasonic wave transmitting means, ultrasonic wave detecting means, and signal processing means, and the method includes detecting the quality of the metallic material based on ultrasonic wave propagation characteristics of the material.

7. (Withdrawn) The materials quality control method according to claim 6, wherein the material quality data detected by the materials quality sensor is crystal grain size of a crystal-containing metallic material in a path of ultrasonic wave propagation.

8. (Withdrawn) The materials quality control method according to claim 7, including generating an ultrasonic wave by irradiating the metallic material with pulsed laser light.

9. (Withdrawn) The materials quality control method according to claim 7, including detecting ultrasonic vibration of the metallic material based on a phase difference between the laser light irradiatling the metallic material, and a reflected beam of the irradiatling light.

10. (Withdrawn) The materials quality control method according to claim 1, including heating the material by induction,

11. (Withdrawn) The materials quality control method according to claim 1, wherein the metallic material is selected from the group consisting of an iron-containing alloy, an aluminum-containing alloy, a copper-containing alloy, and a titanium-containing alloy.

12. (Withdrawn) The materials quality control method according to claim 1, including heating an iron-and-steel material by induction.

13. (Currently Amended) An apparatus for controlling materials quality in a rolling, forging, or leveling process, the apparatus comprising:

at least one ~~means~~ of a heater for ~~each of~~ heating a metallic material, a processor for processing a metallic material by at least one of rolling, forging, ~~or~~ and leveling the metallic material, and a cooler for cooling the metallic material;

data settings calculation means connected to a manufacturing line for manufacturing a metallic product of desired size and shape, wherein, in accordance with information on size and shape of the metallic material, on target size and shape of the product, and on composition of the metallic material, the information being ~~given from~~ output by a host computer, the data settings calculation means calculates and outputs data settings for the ~~heating means~~ heater, the ~~processing means~~ processor, and the ~~cooling means~~ cooler;

a heating controller, a processing controller, and a cooling controller which control ~~a~~ the heater, ~~a~~ the processor, and ~~a~~ the cooler, respectively, based on the data settings;

a materials quality sensor installed downstream of at least one of the heater, the processor, and the cooler in the manufacturing line ~~to measure qualitative data of~~, the materials quality sensor generating ultrasonic waves in the metallic material by irradiating the metallic material with exciting laser light, and detecting the ultrasonic waves propagated in the metallic material based on interference between the exciting laser light irradiating the metallic material and reflected exciting laser light reflected

from the metallic material, and measuring quality of the metallic material based on ultrasonic wave propagation characteristics of the ultrasonic waves detected; and

heating correction means, processing correction means, and cooling correction means, ~~each of which, to ensure that the qualitative data measured by the materials quality sensor will agree with target data, corrects~~ for

calculating deviation between target quality data of the metallic material and the quality of the metallic material that is measured,

calculating an influence coefficient of influence on the quality of the metallic material that is measured, at a material quality measuring point, from changes in heating controlled by the heating controller, changes in processing conditions controlled by the processing controller, and changes in cooling conditions controlled by the cooling controller, using a materials quality model based on a schedule of passage of the metallic material through the manufacturing line, rolling rate of the metallic material, and temperature of the metallic material,

determining correction gains of each of the heating controller, the processing controller, and the cooling controller based on control response and transfer time of each of the heating controller, the processing controller, and the cooling controller at the material quality measuring point, and determining weighting coefficients of the correction gains of each of the heating controller, the processing controller, and the cooling controller, and

based on the deviation of the quality of the metallic material that is measured from the target quality data, the influence coefficients, the correction gains, and the weighting coefficients, correcting the data settings output ~~from~~ by the data settings calculation means to the ~~heating means~~ heater, the ~~processing means~~ processor, and the ~~cooling means~~ cooler, upstream ~~with respect to~~ of the materials quality sensor.

14. (Currently Amended) An apparatus for controlling materials quality in a rolling, forging, or leveling process, the apparatus comprising:

at least one ~~means for each~~ of heating means for heating a metallic material, processing means for processing a metallic material by at least one of rolling, forging, ~~or~~ and leveling the metallic material, and cooling means for cooling the metallic material;

data settings calculation means connected to a manufacturing line for manufacturing a metallic product of desired size and shape, wherein, in accordance with information on size and shape of the metallic material, on target size and shape of the product, and on composition of the metallic material, the information being ~~given from~~ output by a host computer, the data settings calculation means calculates and outputs data settings for the heating means, the processing means, and the cooling means;

a heating controller, a processing controller, and a cooling controller which control ~~a heater~~ the heating means, ~~a processor~~ the processing means, and ~~a cooler~~ the cooling means, respectively, based on the data settings;

a materials quality sensor installed downstream of at least one of the heating means, the processing means, and the cooling means in the manufacturing line ~~to measure qualitative data of~~, the materials quality sensor generating ultrasonic waves in the metallic material by irradiating the metallic material with exciting laser light, and detecting the ultrasonic waves propagated in the metallic material based on interference between the exciting laser light irradiating the metallic material and reflected exciting laser light reflected from the metallic material, and measuring quality of the metallic material based on ultrasonic wave propagation characteristics of the ultrasonic waves detected;

materials quality model computing means for estimating, using a materials quality model, the quality of the metallic material, at ~~the~~ a measuring position, from actual heating conditions, processing conditions, and cooling conditions of the metallic material;

materials quality model learning means for comparing data measurements by the materials quality sensor to arithmetic results ~~of~~ output by the materials quality

model computing means, and ~~learning~~ identifying, from the comparing, an error ~~of~~ in the materials quality model; and

materials quality model correction means for correcting the materials quality model by correcting the arithmetic results ~~of~~ output by the materials quality model computing means in accordance with the ~~learning obtained~~ error output by the materials quality model learning means, wherein the data settings calculation means calculates and outputs data settings for each of the heating means, the processing means, and the cooling means, in accordance with as-corrected-material quality data estimates that the materials quality model correction means outputs.

15. (Currently Amended) An apparatus for controlling materials quality in a rolling, forging, or leveling process, the apparatus comprising:

at least one ~~means for each~~ of heating means for heating a metallic material, processing means for processing a metallic material by at least one of rolling, forging, ~~or~~ and leveling the metallic material, and cooling means for cooling the metallic material;

data settings calculation means connected to a manufacturing line for manufacturing a metallic product of desired size and shape, wherein, in accordance with information on size and shape of the metallic material, on target size and shape of the product, and on composition of the metallic material, the information being ~~given from~~ output by a host computer, the data settings calculation means calculates and outputs data settings for the heating means, the processing means, and the cooling means;

a heating controller, a processing controller, and a cooling controller which control ~~a heater~~ the heating means, ~~a processor~~ the processing means, and ~~a cooler~~ the cooling means, respectively, based on the data settings;

a materials quality sensor installed downstream of at least one of the heating means, the processing means, and the cooling means in the manufacturing line ~~to measure qualitative data of~~, the materials quality sensor generating ultrasonic waves in

the metallic material by irradiating the metallic material with exciting laser light, and detecting the ultrasonic waves propagated in the metallic material based on interference between the exciting laser light irradiating the metallic material and reflected exciting laser light reflected from the metallic material, and measuring quality of the metallic material based on ultrasonic wave propagation characteristics of the ultrasonic waves detected; and

materials quality model computing means for estimating, using a materials quality model, the quality of the metallic material at a materials quality control point located at ~~any~~ a position downstream with respect to the materials quality sensor, wherein the data settings calculation means calculates and outputs data settings for each of the heating means, the processing means, and the cooling means so that arithmetic results output by the materials quality model computing means will agree with ~~the~~ target quality data ~~given from~~ of the metallic material output by the host computer.

16. (Currently Amended) An apparatus for controlling materials quality in a rolling, forging, or leveling process, the apparatus comprising:

at least one ~~means~~ of a heater for ~~each of~~ heating a metallic material, a processor for processing a metallic material by at least one of rolling, forging, ~~or~~ and leveling the metallic material, and a cooler for cooling the metallic material;

data settings calculation means connected to a manufacturing line for manufacturing a metallic product of desired size and shape, wherein, in accordance with information on size and shape of the metallic material, on target size and shape of the product, and on composition of the metallic material, the information being ~~given from~~ output by a host computer, the data settings calculation means calculates and outputs data settings for the ~~heating means~~ heater, the ~~processing means~~ processor, and the ~~cooling means~~ cooler;

a heating controller, a processing controller, and a cooling controller which control ~~a~~ the heater, ~~a~~ the processor, and ~~a~~ the cooler, respectively, based on the data settings;

a materials quality sensor installed downstream of at least one of the heater, the processor, and the cooler in the manufacturing line ~~to measure qualitative data of~~, the materials quality sensor generating ultrasonic waves in the metallic material by irradiating the metallic material with exciting laser light, and detecting the ultrasonic waves propagated in the metallic material based on interference between the exciting laser light irradiating the metallic material and reflected exciting laser light reflected from the metallic material, and measuring quality of the metallic material based on ultrasonic wave propagation characteristics of the ultrasonic waves detected; and

heating correction means, processing correction means, and cooling correction means ~~, each of which, to ensure that the quality of the material at a materials quality control point located in any position downstream with respect to the materials quality sensor, will agree with the target data given from the host computer, correct~~ for

calculating deviation between target quality data of the metallic material and the quality of the metallic material that is measured,

calculating an influence coefficient of influence on the quality of the metallic material at a material quality control point, downstream of a material quality measuring point, from changes in material quality of the metallic material measured at the material quality measuring point,

calculating an influence coefficient of influence on quality of the metallic material that is measured, at the material quality control point, from changes in heating controlled by the heating controller, changes in processing conditions controlled by the processing controller, and changes in cooling conditions controlled by the cooling controller, using a materials quality model based on a schedule of passage of the metallic material through the manufacturing line, rolling rate of the metallic material, and temperature of the metallic material,

determining correction gains of each of the heating controller, the processing controller, and the cooling controller based on control response and transfer time of each of the heating controller, the processing controller, and the cooling controller at the material quality measuring point, and determining weighting coefficients of the correction gains of each of the heating controller, the processing controller, and the cooling controller, and

based on the deviation of the quality of the metallic material that is measured from the target quality data, the influence coefficients, the correction gains, and the weighting coefficients, correcting the data settings output by the data settings calculation means to the heater, the processor, and the cooler, upstream of the materials quality sensor, correcting the data settings output from the data settings calculation means to the ~~heating means~~ heater, the ~~processing means~~ processor, and the ~~cooling means~~ cooler disposed downstream with respect to the materials quality sensor.

17. (Withdrawn) The rolling process materials quality control method according to claim 2, wherein the manufacturing line comprises

a water-cooling site at immediately after of a processing site which uses a rolling mill, and a materials quality sensor at both or either of two locations, one location being between the processing site and the cooling site, and the other location being an outlet of the cooling site.

18. (Withdrawn) The rolling process materials quality control method according to claim 3, wherein the manufacturing line comprises
a water-cooling site at immediately after of a processing site which uses a rolling mill, and

a materials quality sensor at both or either of two locations, one location being between the processing site and the cooling site, and the other location being an outlet of the cooling site.

19. (Withdrawn) The rolling process materials quality control method according to claim 4, wherein the manufacturing line comprises

a water-cooling site at immediately after of a processing site which uses a rolling mill, and a materials quality sensor at both or either of two locations, one

location being between the processing site and the cooling site, and the other location being an outlet of the cooling site.

20. (Withdrawn) The materials quality control method according to claim 2, wherein the materials quality sensor comprises ultrasonic wave transmitting means, ultrasonic wave detecting means, and signal processing means, and the method includes detecting the quality of the metallic material based on ultrasonic wave propagation characteristics of the material.

21. (Withdrawn) The materials quality control method according to claim 3, wherein the materials quality sensor comprises ultrasonic wave transmitting means, ultrasonic wave detecting means, and signal processing means, and the method includes detecting the quality of the metallic material based on ultrasonic wave propagation characteristics of the material.

22. (Withdrawn) The materials quality control method according to claim 4, wherein the materials quality sensor comprises ultrasonic wave transmitting means, ultrasonic wave detecting means, and signal processing means, and the method includes detecting the quality of the metallic material based on ultrasonic wave propagation characteristics of the material.

23. (Withdrawn) The materials quality control method according to claim 2, including heating the material by induction.

24. (Withdrawn) The materials quality control method according to claim 3, including heating the material by induction.

25. (Withdrawn) The materials quality control method according to claim 4, including heating the material by induction.

26. (Withdrawn) The materials quality control method according to claim 2, wherein the metallic material is selected from the group consisting of an iron-containing alloy, an aluminum-containing alloy, a copper-containing alloy, and a titanium-containing alloy.

27. (Withdrawn) The materials quality control method according to claim 3, wherein the metallic material is selected from the group consisting of an iron-containing alloy, an aluminum-containing alloy, a copper-containing alloy, and a titanium-containing alloy.

28. (Withdrawn) The materials quality control method according to claim 4, wherein the metallic material is selected from the group consisting of an iron-containing alloy, an aluminum-containing alloy, a copper-containing alloy, and a titanium-containing alloy.

29. (Withdrawn) The materials quality control method according to claim 2, including heating an iron-and-steel material by induction.

30. (Withdrawn) The materials quality control method according to claim 3, including heating an iron-and-steel material by induction.

31. (Withdrawn) The materials quality control method according to claim 4, including heating an iron-and-steel material by induction.